NUTRITION REVIEWS

VOL. 1 APRIL, 1943 No. 6

PEACETIME AND WARTIME FUNCTIONS OF THE FOOD AND NUTRITION BOARD, NATIONAL RESEARCH COUNCIL

The Food and Nutrition Board of the National Research Council is a group of experts in food and nutritional subjects, appointed by the Council to provide advisory service to government agencies. Although there is no attempt to allocate representation geographically, there are members from points as widespread as Massachusetts and California, Ontario and Alabama. On invitation by the Council they meet for consideration of current nutritional problems and projects. But first, before describing the Board, it will be well to consider the foundations on which the operations are based.

President Abraham Lincoln, in approving the unanimous act of Congress—resulting from the deliberation and inspiration of five scientists, one naval officer, and a statesman to secure the highest type of scientific advice to the government—founded the National Academy of Sciences in 1863. It was incorporated by congressional act to "advance science, and especially to investigate, examine, experiment, and report on any subject of science or art whenever called upon by any department of the government." Membership in the Academy is limited to three hundred, of which fifty may be foreign associates.

In 1916, when it was foreseen the United States would probably become involved in World War I, the Academy offered its services to President Woodrow Wilson. The Academy proposed to aid the coordination of the nongovernmental scientific and technical resources of the country with the military and naval agencies of the government in the interests of national security.

President Wilson accepted the offer and asked the Academy to organize a central committee, which was called the National Research Council. During the ensuing two years the Council was the Department of Science and Research of the Council of National Defense, and also the Science and Research Division of the Signal Corps of the Army.

In 1918 President Wilson issued an executive order directing the Academy to perpetuate the National Research Council. Thus through its Divisions of Anthropology and Psychology, Biology and Agriculture, Chemistry and Chemical Technology, Engineering and Industrial Research, Geology and Geography, Medical Sciences, and Physical Sciences, the Council has continued to give aid and encouragement to research, coordination, and dissemination of scientific knowledge.

More than a year in advance of this country's entry into the present war the National Research Council was requested by federal officials of the National Defense Advisory Commission to organize a group of experts in food and nutrition on which the government might call for advice. As its work expanded and its membership increased, the Committee on Food and Nutrition became, in 1942, the Food and Nutrition Board. From the beginning until the end of 1941 Dr. Russell M. Wilder, of the Mayo Clinic, served as chairman, and when he resigned the chief responsibility was entrusted to Dr. Frank G. Boudreau, the present chairman, with Professor H. C. Sherman as vice-chairman. Since his return to the United States, after twelve years with the Health Organization of the League of Nations, Dr. Boudreau has been Executive Director of the Milbank Memorial Fund in New York.

The Board consists of forty-one members, including biochemists, physicians with special knowledge of nutrition, food economists, technical experts, and liaison representatives of certain federal departments, including the Army and the Navy.

As with the Academy and the Council, the work of the Board and its office staff are financed partly through the income from the Carnegie Corporation grant, partly by grants from other Foundations, and partly by contract with certain federal departments which call on the Board for continuing advisory service. The Board and committee members are reimbursed only for travel and subsistence expenses.

Fortification of certain staple foods is a logical corollary of the advancing knowledge of nutrition. At the time of the Board's organization the Food and Drug Administration was conducting hearings preparatory to the promulgation of standards and definitions for flour and related products. Similar hearings on bread followed later. In both cases members of the Food and Nutrition Board presented facts and opinions helpful in shaping the program which is now effectively providing millions of people with more adequate amounts of thiamine, niacin, and iron. The riboflavin provision is held in abeyance, pending greater production of this vitamin. The War and Navy Departments have ordered that all flour for the armed forces must be enriched, and the first food distribution order by the newly appointed Food Administrator makes enriched bread, according to the recommendations of the Food and Nutrition Board, universal throughout the country.

Dietary goals are essential prerequisites to the attainment of good nutrition. In 1935 the Health Organization of the League of Nations adopted dietary standards which were widely accepted. By 1940 it was obvious that revised standards had become necessary. But with the war coming on it was impossible for the League to undertake the responsibility, and thus one of the first tasks of the Food and Nutrition Board was "to define in accordance with newer information the recommended daily allowances for the various dietary essentials for people of different ages and varied activities."

Thorough search of the literature and consultation with experts enabled the Board's Committee on Dietary Allowances to formulate a set of values which now guide the planning and appraisal of good diets. The Recommended Dietary Allowances have often been termed the "yard-stick of good nutrition." The values are employed widely for both peace- and wartime dietaries of civilian and military forces, both in the United States and abroad.

"Recommended Dietary Allowances" have been recently published in pamphlet form, no. 115 of the Reprint and Circular Series, National Research Council, January 1943. Canadian authorities have adopted essentially the same values, and keen interest is being expressed also by nutrition experts in other Allied Nations. In recent announcements about the food outlook in the United States the Food Administrator has weighed the estimated supply of nutrients against the "Recommended Dietary Allowances."

Long before the United States entered the present war the Board's Committee on Nutrition of Industrial Workers foresaw the need for special information and efforts to improve the nutrition of industrial workers. The committee sponsored, in the summer of 1941, a survey by Dr. Robert S. Goodhart of feeding conditions in more than thirty industrial plants from New England to southern California. He found that in the majority of plants proper feeding facilities were nonexistent. In war industries which had greatly expanded the insufficient food service facilities had become totally inadequate. Workers chose poorly balanced meals, even when a good choice was available. The results of the survey were summarized in a report "The Food and Nutrition of Industrial Workers in Wartime,"

pamphlet no. 110, Reprint and Circular Series of the National Research Council, April 1942.

To interest government, management, and labor in nutrition more precise knowledge concerning the influence of diets on health, absenteeism, and accidents was needed. So the Committee has undertaken to sponsor rigidly controlled studies in several widely separated cities. The survey and the studies help to provide the background for the work of the Nutrition in Industry Section, Nutrition Division, Office of Defense Health and Welfare Services, to which Dr. R. S. Goodhart, P. A. Surgeon (R), U. S. Public Health Service, is now Technical Adviser. Meanwhile, the Board's Committee on the Nutrition of Industrial Workers is preparing a further report. It will outline as specifically as possible recommendations for feeding industrial workers under the widely varied conditions in small and large plants to promote maximum nutritional health, and thus war production.

The Office of the Quartermaster General, in the autumn of 1942, asked the National Research Council to set up an organization to expedite the assembly, coordination, and appraisal of food composition data. The Council asked Dr. C. A. Elvehjem, of the University of Wisconsin, to become chairman of a new group designated as the Committee on Food Composition. Dr. Paul L. Pavcek, of Dr. Elvehjem's laboratory, came to the Food and Nutrition Board as Secretary of the Committee, and at this writing other nutrition specialists also are employed by the Committee, assigned to work in two of the federal laboratories in Washington. Dr. Pavcek is devoting full time to assembly and coordination of food composition data, particularly to the proximate composition and to newer data on vitamin and mineral content of all foods important to the army. Considerable data on foods of many kinds are available in numerous laboratories about the country and need only to be brought to a focal point for appraisal by a competent group of specialists. Dr. Elvehjem's committee is designed to fulfill that purpose. Meeting frequently with Drs. Elvehjem and Pavcek are, among others, representatives of the Agricultural Research Administration of the U. S. Department of Agriculture; the Bureau of Home Economics; the Office of Experiment Stations; the U. S. Plant, Soil and Nutrition Laboratory; the Vitamin Laboratory of the Food and Drug Administration; the Canadian Nutrition Service Division; and the Combined Food Board of the Allied Nations.

The request by the Office of the Quartermaster General, seconded by the Surgeon General of the War Department and by the Navy and the Marine Corps, calls for speedy action. To do that the Committee needs the help of all of you—food chemists, nutritionists, and others—through your voluntary contribution of data on food composition. This effort is unconventional in one important respect. To serve the purpose well we cannot be content with data which are already published; the committee needs also the many new unpublished figures which are on record in various laboratories. Ordinarily these data which have served the purpose of the investigator might be filed away for long periods. Authors might wish to confirm the data or to await an opportunity to present a paper or publish a completed series of articles. But war needs refuse to wait for the usual procedure.

The Committee solicits most earnestly the voluntary contribution of food composition data which can help quickly to "round out" information to help the Army and Navy better to plan their foods, their menus, and thus their striking force. This emergency use should not prevent later publication on the part of authors, and it is the intention of the Committee that new and unpublished information is to be used only for the purposes described above.

Increasingly during recent months the Board has been asked by the Department of

Agriculture and by other departments for advice on various aspects of foods relating to both production and distribution. Dr. Russell M. Wilder has taken leave from the Mayo Clinic to serve as Chief of the Civilian Requirements Branch of the Food Distribution Administration. He expects to draw heavily on the advice and information of the Food and Nutrition Board. To implement recommendations by the Board into policies of food production and distribution for civilians, Dr. Wilder has established a Civilian Nutrition Committee on which sit several members of the Board. This new committee provides the means for direct and continuing wartime food advisory service.

Space is too limited to permit even the briefest description of many of the activities of the Food and Nutrition Board. Its committees have reported on dehydrated fruits and vegetables, on fats, on milk, and on the nation's protein supply. One group is sponsoring a survey on dental caries, another on the nutritional aspects of aging, while a different group formulates a report on methods of early recognition of dietary deficiencies.

Finally, it should be pointed out that the Food and Nutrition Board and its committees are in contact through three members with the Canadian authorities in food and nutrition, and that representatives of the British Ministry of Food attend its sessions regularly. When the war is over this international cooperation should become widely extended.

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RECOMMENDED DIETARY ALLOWANCES*

FOOD AND NUTRITION BOARD, NATIONAL RESEARCH COUNCIL

Dietary standards to serve as a goal for good nutrition and as a "yardstick" by which to measure progress toward that goal have long been needed. In 1935 the League of Nations made a concerted group effort to formulate such a yardstick. One of the first concerns of the Food and Nutrition Board (formerly the Committee on Food and Nutrition of the National Research Council), established in 1940 to advise on nutrition problems in connection with National Defense, was to define in accordance with newer information the recommended daily allowances for the various dietary essentials for people of different ages.

The difficulty in such an undertaking lies in the lack of sufficient experimental evidence on which to estimate requirements for the various nutrients with any great degree of accuracy. Judgments as to requirements are necessarily based on incomplete and often conflicting reports of research and clinical observations and on data derived from work on animals. Experiments with the various vitamins also differ with regard to procedure and interpretation. These variables explain the wide divergence in "requirements" as set forth in current literature on nutrition.

In view of the confusion caused by this great variation in standards used, it seemed desirable to attempt to derive a table of allowances which would represent the best available evidence on the amounts of the various nutritive essentials to include in practical diets. With this aim in view, the literature on the subject of each of the dietary essentials was critically appraised, and in addition judgments as to the various

* This article is a reprint of the National Research Council, Reprint and Circular Series, No. 115, January 1943, and is published, with permission of the National Research Council, because the material is of vital importance at this time.

TABLE 1.—RECOMMENDED DIETARY ALLOWANCES*

Food and Nutrition Board, National Research Council

	Calories	Protein	Calcium	Iron	Vitamin A***	Thiamin (B_1)	Riboflavin	Niacin (Nicotinic acid)	Ascorbic acid	Vitamin D
		grams	*grams*	*mg.*	*I.U.*	*mg.***	*mg.*	*mg.*	*mg.***	*I.U.*
Man (70 Kg.)										
Sedentary	2,500	.....	.....	.....	.....	1.5	2.2	15	.....	.....
Moderately active	3,000	70	0.8	12	5,000	1.8	2.7	18	75	†††
Very active	4,500	.....	.....	.....	.....	2.3	3.3	23	.....	.....
Woman (56 Kg.)										
Sedentary	2,100	.....	.....	.....	.....	1.2	1.8	12	.....	.....
Moderately active	2,500	60	0.8	12	5,000	1.5	2.2	15	70	†††
Very active	3,000	.....	.....	.....	.....	1.8	2.7	18	.....	.....
Pregnancy (latter half)	2,500	85	1.5	15	6,000	1.8	2.5	18	100	400 to 800
Lactation	3,000	100	2.0	15	8,000	2.3	3.0	23	150	400 to 800
Children up to 12 years:										
Under 1 year†	100/Kg.	3 to 4/Kg.	1.0	6	1,500	0.4	0.6	4	30	400 to 800
1–3 years††	1,200	40	1.0	7	2,000	0.6	0.9	6	35	†††
4–6 years	1,600	50	1.0	8	2,500	0.8	1.2	8	50	.....
7–9 years	2,000	60	1.0	10	3,500	1.0	1.5	10	60	.....
10–12 years	2,500	70	1.2	12	4,500	1.2	1.8	12	75	.....
Children over 12 years:										
Girls, 13–15 years	2,800	80	1.3	15	5,000	1.4	2.0	14	80	†††
16–20 years	2,400	75	1.0	15	5,000	1.2	1.8	12	80	.....
Boys, 13–15 years	3,200	85	1.4	15	5,000	1.6	2.4	16	90	†††
16–20 years	3,800	100	1.4	15	6,000	2.0	3.0	20	100	.....

* Tentative goal toward which to aim in planning practical dietaries; can be met by a good diet of natural foods. Such a diet will also provide other minerals and vitamins, the requirements for which are less well known.

** 1 mg. thiamin equals 333 I.U.; 1 mg. ascorbic acid equals 20 I.U.

*** Requirements may be less if provided as vitamin A; greater if provided chiefly as the pro-vitamin carotene.

† Needs of infants increase from month to month. The amounts given are for approximately 6–8 months. The amounts of protein and calcium needed are less if derived from human milk.

†† Allowances are based on needs for the middle year in each group (as 2, 5, 8, etc.) and for moderate activity.

††† Vitamin D is undoubtedly necessary for older children and adults. When not available from sunshine, it should be provided probably up to the minimum amounts recommended for infants.

Further Recommendations, Adopted 1942:

The requirement for *iodine* is small; probably about 0.002 to 0.004 milligram a day for each kilogram of bodyweight. This amounts to about 0.15 to 0.30 milligram daily for the adult. This need is easily met by the regular use of iodized salt; its use is especially important in adolescence and pregnancy.

The requirement for *copper* for adults is in the neighborhood of 1.0 to 2.0 milligrams a day. Infants and children require approximately 0.05 per kilogram of body weight. The requirement for copper is approximately one-tenth of that for iron.

The requirement for *vitamin K* is usually satisfied by any good diet. Special consideration needs to be given to newborn infants. Physicians commonly give vitamin K either to the mother before delivery or to the infant immediately after birth.

requirements were solicited from a considerable number of nutrition authorities in addition to members of the Board, especially those whose research bore particularly on the problem. On the basis of this evidence tentative allowances were formulated. These were resubmitted to contributors for criticism and reformulated in the light of the comments made. The values thus revised were presented before a section meeting of the American Institute of Nutrition in 1941 and members invited to submit further evidence for any changes that seemed indicated. After final discussion and some minor revisions they were adopted by the Board in May, 1941. The values as presented thus represented the combined judgment of more than fifty persons qualified to express an opinion on the subject. This does not mean, of course, that every contributor would fully agree with all the figures as given. It does mean, however, that the values are ones they were willing to accept tentatively, until standards derived from more extensive and exact research data can be obtained. The term "Recommended Allowances" rather than "Standards" was adopted by the Board to avoid any implication of finality.

In using these recommendations, it is important that the purpose and general policies in formulating them should be understood:

What the Allowances Provide

The allowances for specific nutrients are intended to serve as a guide for planning adequate nutrition for the civilian population of the United States. The quantities given were planned to provide not merely the minima sufficient to protect against actual deficiency disease but a fair margin above this to insure good nutrition and protection of all body tissues. Since the actual requirements for these purposes are not known it is recognized that the margins of safety may vary considerably for the different factors. The Board realizes that the values proposed will need to be revised from time to time as more knowledge of nutritive requirements becomes available.

No Allowances for Losses in Cooking

It should be pointed out that the vitamin figures are calculated requirements for food as eaten and do not allow for losses in cooking. Since such losses may be extensive, especially of the water-soluble vitamins, provision should be made for them in planning practical dietaries.

Other Factors for which Allowances are not Given

In addition to the three factors of the B complex included, other members of the group, such as vitamin B_6 and pantothenic acid, should be given consideration. But at the present time no specific values can be given for the amount required in the human dietary. It should be added, however, that foods supplying an adequate amount of thiamin, riboflavin, and niacin (nicotinic acid) will tend to supply an adequate amount of the remaining B vitamins. Similarly diets providing adequate amounts of protein, calcium, and iron will tend to supply other needed minerals, though these are not listed. There is urgent need for continued research on the requirements for all dietary essentials, especially for children.

Allowances Based on Average Size, Sex, and Activity for Normal Individuals

The allowances for adults are given for the 70 Kg. man and the 56 Kg. woman at three levels of activity. They will need to be proportionately increased or decreased for larger or smaller individuals. It will be noted that the allowances for thiamin, riboflavin, and niacin (nicotinic acid) are proportional to the caloric intake. This relationship has been established for thiamin, and it has been assumed to hold also for riboflavin and nicotinic acid since, like thiamin, they are part of the enzymic system involved in the metabolism of carbohydrate.

The allowances for children are given by age groups, and for boys and girls separately after 12 years, since from that age the growth curves and levels of activity for the two sexes differ. The values presented are in each case for the middle year in the group, and represent amounts needed for children of average size and activity. The needs for individual children may be proportionately larger or smaller depending upon size and activity.

It is to be understood that these allowances are for persons in health, and that needs may vary markedly in disease. For example, in febrile conditions there is usually an increased need for calories, thiamin and ascorbic acid. The need for these or other constituents may also be greatly altered in other diseases, especially those of the alimentary tract, which interfere with normal absorption.

Slight Changes in 1941 Allowances

Recommendations as adopted in 1941 remain substantially unchanged at this writing—approximately two years after the initial compilation of data.

Consideration has been given to three more nutrients not covered in the original recommendations. They are iodine, copper and vitamin K. Recommendations for these substances are now included for the first time in this summary.

Diet Plans that Meet the Dietary Allowances

In using the recommended allowances it should be emphasized that the amounts of the various nutrients provided for in these recommended allowances, with the exception of vitamin D can be obtained through a good diet of natural foods including foods like enriched white flour and bread which have been improved according to recommendations of the Board.

The safest way to insure that the dietary allowances are met is to include certain foods in the diet daily in specified amounts. One dietary pattern which contains a variety of foods commonly available is given below:

List I

Milk	1 pint
Egg	1 daily, if possible. (On days not used, beans, peanuts, cheese, or more milk or meat to be used instead)
Meat, fish or fowl	1 or more servings
Potato	1 or more
Vegetables	2 or more servings. One green or yellow
Fruits	2 or more. One citrus fruit or tomato or other good source of vitamin C
Cereals and bread	Whole-grain or enriched
Other foods as needed to complete the meals	

This list is based on the needs of the average adult. For children the milk needs to be increased but the kinds of foods to include remain the same.

Another list using less milk and lean meat is given as illustrative of the varied ways in which the allowances may be met.

List II

Turnip greens	1 cup
Sweet potatoes	3
Peanuts	20 nuts or 2 tablespoons of peanut butter
Beans or cowpeas	1½ oz.
Tomatoes	1 cup
Corn meal	3 oz.
Enriched flour	3 to 4 oz.
Milk (fresh, evaporated or dried)	¾ qt.
Lean pork	small serving 3 to 4 times a week
Molasses, fat, etc., to complete the meals	

Calculations show that both these lists meet the dietary allowances. It should be pointed out, however, that every food is needed in the amounts specified. If any food is omitted, therefore, it should be replaced by another of equal value.

There are many other combinations of foods that will also cover these allowances. It is expected that nutrition workers in various parts of the country will translate these

allowances into appropriate quantities of foodstuffs available in their localities and suited to the income level of the group concerned. Such allowances, expressed in terms of everyday foods, can then be widely used in practical nutrition work.

DIETARY FACTORS AND "FATTY LIVERS"

The lipotropic action of choline was observed in early experiments with dogs by Junkersdorf and Kohn (*Arch. ges. Physiol. (Pflügers)* **211,** *612 (1926)*). Best, Hershey, and Huntsman (*Am. J. Physiol.* **101,** *7 (1932)*) reported a similar action in the rat. Since these early experiments it has been repeatedly demonstrated, largely through the work of Griffith, that in the absence of sufficient dietary choline, characteristic renal hemorrhagic degeneration occurs. This observation resulted in an intensification of research to define the specific functions of choline. Meanwhile, a relationship had been found between sulfur-containing amino acids and choline. Supplemental amounts of cystine in a choline deficient diet increase the deposition of liver fat and severity of kidney damage.

It has been thought that an antagonism prevailed between cystine and choline but Mulford and Griffith (*J. Nutrition* **23,** *91 (1942)*) have recently raised the question whether the antagonistic effect of cystine is an indirect one. They found that the addition of supplemental cystine to low choline diets containing 18 per cent casein improves the nutritional level of the diet and believe that this indirectly increases the choline requirement. The addition of 0.1 to 0.2 per cent cystine or a similar amount of methionine to a diet containing 18 per cent purified casein, lard, sucrose, salt mixture, calcium carbonate, agar, powdered yeast, and fortified cod liver oil, resulted in heavier and larger rats with little or no increase in food consumption. The most efficient utilization of food was in evidence during the first twenty days of the experiment, during the early growth stages of the young rat, thus indicating a greater need for cystine during this period. The deposition of liver fat and the incidence of renal hemorrhagic degeneration were aggravated by increased supplements of cystine. Increasing the cystine supplement above 0.1 to 0.2 per cent had no additional effect on the requirement of choline.

That methionine could, like choline, assist in the prevention of fatty livers was shown by Tucker and Eckstein (*J. Biol. Chem.* **121,** *479 (1937)*). The same replaceability of choline by methionine for the prevention of hemorrhagic kidneys was demonstrated by Griffith and Mulford (*J. Am. Chem. Soc.* **63,** *929 (1941)*). The explanation for this interrelationship was supplied by the hypothesis, presented by du Vigneaud, Chandler, Moyer, and Keppel (*J. Biol. Chem.* **131,** *57 (1939)*), that methionine serves as a source of labile methyl groups which can be used in the synthesis of choline. This hypothesis was later verified by du Vigneaud, Chandler, Cohn, and Brown (*J. Biol. Chem.* **134,** *18 (1940)*) in experiments in which the methyl group of methionine was labeled with deuterium. Methionine may also be used by the rat as a source of sulfur for the synthesis of cystine, a fact first indicated by the work of Jackson and Black (*J. Biol. Chem.* **98,** *465 (1932)*) and later confirmed by many investigators.

Mulford and Griffith found that in the absence of dietary choline, 30 per cent casein in the diet was necessary to supply sufficient methionine and cystine to prevent all signs of cystine and choline deficiency. They interpret data from certain of their experiments as evidence that any molecule of methionine used as a source of methyl group is not available as a source of cystine sulfur. Experimental evidence which does not seem

to support the conclusion of Griffith and Mulford has been obtained in liver tissue experiments by Binkley and du Vigneaud (*J. Biol. Chem.* **144,** *507 (1942)*).

It is well established that dietary choline prevents renal hemorrhage and is specifically associated with the prevention of abnormal accumulations of fat in the liver. In 1936 Whipple and Church (*J. Biol. Chem.* **109,** *cvii (1936)*) called attention to the relation of the B-vitamins to liver fat metabolism. These results have been confirmed by several other workers. McHenry and coworkers in a series of papers have reported that thiamine must be present in the diet in order to produce fatty livers caused by choline deficiency, and also that a different type of fatty liver, produced by biotin in the diet, is prevented by the feeding of lipocaic or inositol. The problem has been further clarified by the recent study of Engel (*J. Nutrition* **24,** *175 (1942)*). Data were obtained with young rats fed a purified diet containing 18 per cent casein, sucrose, a salt mixture, and supplements of carotene, vitamin D, and the crystalline B-vitamins. With this diet, it was possible to study the lipotropic action of several of the B-vitamins. When thiamine, riboflavin, pantothenic acid, pyridoxine, corn oil, and choline were fed to growing rats for a three week period, an abnormal accumulation of liver fat occurred. Two mg. of choline chloride per rat daily failed to prevent the kidney hemorrhagic degeneration and the abnormally high liver fat. Increasing the level of choline to 10 mg. was necessary to obtain the maximum lipotropic action of choline but normal liver fat levels still were not obtained. When inositol was given in addition to adequate choline, normal liver fat values were obtained. Prolonged feeding of a diet deficient in pyridoxine or the essential fatty acids but adequate in choline resulted in fatty livers. These results indicate that pyridoxine, inositol, and a source of the essential fatty acids are necessary as well as choline for the control of liver fat deposition in the rat.

It is evident that diet may be directly concerned with the development of fatty livers. It is of importance that the factors having lipotropic activity be thoroughly understood because of the widespread occurrence of fatty livers in various diseases. These studies contribute to the intelligent use of dietary therapy and vitamin supplementation (B-complex including choline) in certain types of liver disease. However, the main difficulty from the viewpoint of sound clinical application of these nutritional facts is the problem of an early diagnosis of the type of liver disease, particularly whether it is a "fatty liver" or a cirrhotic liver.

THE EFFECT OF STORAGE ON PROTEINS IN CEREAL GRAINS

The federal ever-normal granary program calls for the storage of wheat, corn, and other grains for long periods of time in granaries and warehouses of many types. Feed manufacturers have long been aware of the danger of improper storage of cereals and stock feeds, and millers and bakers have been extremely conscious of the effects of storage of wheat and wheat flour on baking quality as expressed by such criteria as loaf volume and texture.

In 1940 it was estimated that 300 million bushels of new wheat crop went under seal. At that time about 30 million bushels were already under seal from previous crops. During the same period about 465 million bushels of old corn were under seal on farms or stored by the Commodity Credit Corporation. Past experience has taught farmers, elevator men, feed manufacturers, and millers that quality and palatability of cereals are adversely affected by improper storage.

In view of withdrawals of large amounts of

these cereals (for Lend-Lease and local consumption) after many months of storage, it was logical and necessary that information be obtained regarding the effect of storage on protein quality and nutritive value of cereals stored under various conditions and for various lengths of time.

These studies were initiated at Washington by the Protein and Nutrition Division, Bureau of Chemistry and Engineering, United States Department of Agriculture. Previous studies in these laboratories by Jones and Gersdorff (*J. Am. Chem. Soc.* **60,** *723 (1938)*) had shown that marked changes take place in seed proteins during aging, as measured by extraction of nitrogen by neutral salt solutions and by other chemical technics. They noted that soybean meal proteins became partially denatured during storage as measured by decreased solubility in neutral salt solutions.

In 1941, the same investigators (*Cereal Chem.* **18,** *417 (1941)*) described comprehensive studies on the effect of storage on the protein of wheat, white flour, and whole wheat flour. No. 2 red winter wheat of the 1937 crop was cleaned and milled in the U. S. D. A. laboratories. Whole wheat flour and 70 per cent extraction patent flour were prepared and used in the studies. Each type of flour was stored in sealed Mason jars and in cotton bags. The whole wheat kernels were stored in half gallon glass jars and samples of each type of wheat product were stored at 76°F. and 30°F. The storage periods extended over twenty-four months. Samples of each type were removed at regular intervals for study. Routine estimations included moisture, total nitrogen, free ammonia nitrogen, free fatty acids, pure protein, nitrogen extractable with alcohol, sodium chloride and sodium salicylate, amino nitrogen, and nitrogen precipitable with trichloracetic acid. "Digestibility" was recorded as the amount of nitrogen rendered soluble by pepsin and trypsin under controlled conditions.

Three different types of protein alterations occurred: decrease in solubility; partial breakdown, as indicated by decrease in true protein content, decrease in nitrogen precipitable by trichloracetic acid, and by increased amounts of amino nitrogen; and decrease in digestibility. As might be expected, protein changes were greater at 76°F. than at 30°F. and bag storage was more harmful than Mason jar storage. While changes in whole wheat kernels followed the same general trends as those observed for white and whole wheat flour, the changes were not as great. Solubility studies indicated that greatest changes were found in the solubility in sodium chloride of proteins of white flour. When stored in a bag for two years the decrease in sodium chloride soluble proteins was 61 per cent as compared with a 57 per cent decrease when stored for the same period in glass. Enzymatic and oxidative changes were thought to be responsible for the alteration of proteins during storage.

The wheat studies were followed by a similar series of studies on corn by Jones, Divine, and Gersdorff (*Cereal Chem.* **19,** *819 (1942)*). These studies were initiated in 1938, using yellow dent corn. Whole shelled corn and corn meal were stored in bags and glass jars under the same conditions described for wheat. The chemical estimations were identical with those used in the wheat studies.

However, the corn studies included feeding experiments with rats to determine the effect of storage on the nutritive value of corn. The diet consisted of 96 parts of corn, 3 parts of Osborne and Mendel salt mixture, and 1 part of cod liver oil. Water soluble vitamins were furnished by daily forced feedings (0.2 ml.) of a solution containing thiamine, riboflavin, nicotinic acid, and an extract of rice polish.

The findings were similar to those with wheat. Protein alterations occurred, as measured by the chemical methods; and the digestibility of proteins, as measured by peptic and tryptic digests, decreased. Changes

in ground corn proteins were greater than those in whole shelled corn and changes at 76°F. were greater than those at 30°F. Corn which was stored for six months had less growth promoting value than fresh corn. Protein alterations seemed to have reached a maximum at the end of twelve months, since corn which had been stored for two years at 76°F. showed no additional deterioration in growth promoting properties when compared with corn stored for twelve months at the same temperature. All rat growth studies were of forty-two days' duration. During the first six months of storage the gain in weight per gram of corn consumed was the same as for the fresh corn, but with corn stored for twelve and twenty-four months the gain in weight per gram consumed was less.

If such measurable changes in proteins and in the nutritive value of cereals can take place under such ideal experimental storage conditions, there is reason to believe that changes occurring under conditions of farm storage and many types of commercial storage might be even more detrimental. This is important from the standpoint of nutritive value, and may become a matter of great significance when cereals are used for the manufacture of industrial products.

NICOTINIC ACID AS AN ESSENTIAL FOR CHICKS

It is well known that nicotinic acid must be supplied in the diet of the dog, pig, monkey, and man. The rat, on the other hand, has the ability to synthesize this vitamin and does not require it preformed in the diet. Most investigators have concluded that the chick is similar to the rat in this respect.

Two deficiency diseases in chicks have been described which bear a superficial resemblance to pellagra in that a severe dermatitis occurs around the mouth and on the feet. It has been adequately shown however that the dermatitis which occurs when chicks are fed heated rations can be prevented or cured by pantothenic acid. The second type of dermatitis which occurs on purified rations has been shown to be a biotin deficiency. Thus nicotinic acid is not concerned in either of these deficiency syndromes.

The classic Goldberger ration which has been used successfully for nicotinic acid assays with dogs has been shown by the Wisconsin workers to contain suboptimal amounts of several of the factors required by the chick. However, when chicks were grown upon this ration no symptoms of pellagra or blacktongue were noted, nor did nicotinic acid supplements produce marked growth responses. Such evidence for the dispensability of nicotinic acid for the chick was strengthened by the conclusion of Snell and Quarles (*J. Nutrition*, **22,** *483 (1941)*) that nicotinic acid is synthesized by the developing chick embryo.

However, Briggs, Mills, Elvehjem, and Hart (*Proc. Soc. Exp. Biol. Med.*, **51,** *59 (1942)*) have recently reported that the chick does require preformed nicotinic acid in the diet. In continuing the studies of the Wisconsin group on purified rations for the chick they have devised a ration which is low in nicotinic acid, yet fairly complete in the other necessary factors. One hundred g. of this ration contained dextrin 61 g., alcohol extracted casein 18 g., gelatin 10 g., salt mixture 5 g., dicalcium phosphate 1 g., soybean oil 5 g., an eluate fraction equivalent to 5 g. solubilized liver, l-cystine 300 mg., thiamine hydrochloride 300 mg., riboflavin 600 mg., biotin concentrate 15 mg., pyridoxine hydrochloride 400 mg., calcium pantothenate 1.5 mg., choline hydrochloride 150 mg., inositol 100 mg., 2-methyl-1,4-naphthoquinone 500 mg., and alpha-tocopherol 300 mg. In addition, each chick received 3 drops of a vitamin A and D con-

centrate at weekly intervals. Microbiologic assays showed a nicotinic acid content of 0.3 mg. per 100 g. of ration.

Growth studies were conducted starting with day old chicks. These were divided into groups of 6 and nicotinic acid was fed in increasing amounts to the various groups, retaining one group as a control. This group grew at a relatively slow rate; the rate of growth of other groups increased with the amount of nicotinic acid added. No improvement in growth was noted when the amount of nicotinic acid exceeded 1.8 mg. per 100 g. of ration. No data were given regarding food consumption.

"Blacktongue" symptoms appeared when deficient chicks were about 2 weeks of age. The entire mouth cavity and the upper part of the esophagus and crop became inflamed and developed a distinct deep red color. The tip of the tongue was not involved and appeared nearly white. Less nicotinic acid (0.5 mg. per 100 g. of ration) was required for prevention of "blacktongue" symptoms than was required for growth (1.8 mg. per 100 g. of ration).

This work indicates that there is a definite nicotinic acid requirement for the chick and that a deficiency of this factor leads to the development of symptoms not unlike those found in canine blacktongue and in human pellagra.

HIGH PROTEIN DIET AND THIAMINE DEFICIENCY

That replacement of carbohydrate by fat in a low thiamine diet results in a delay in onset of symptoms of thiamine deficiency is now generally recognized. The use of diets rich in carbohydrate offers the quickest means of precipitating thiamine deficiency in experimental animals. This fact is considered due to the increased use and function of the thiamine-containing enzymes necessary in the metabolism of pyruvic acid, an intermediate of carbohydrate metabolism. These observations have contributed to the belief that there is a "wear and tear" loss of an enzyme and its components during its function. On this basis, the "thiamine-sparing" action of fat indicates that the various steps in metabolism of fats do not require thiamine-containing enzymes, at least not to the same degree as carbohydrate metabolism.

Little work has been done in this connection with proteins. Since it has been known for some time that certain amino acids are glycogenic, that is, form glucose (or lead into paths of glucose oxidation in their metabolism) and others (ketogenic) do not, it would be expected that proteins might be intermediate between carbohydrate and fat in their relation to thiamine usage. Accordingly, different proteins should vary in this respect according to their content of glycogenic amino acids.

Banerji (*Biochem. J.* **35,** *1354 (1941)*) studied rats deprived of thiamine on a diet high in protein. He reported that such a diet prevents bradycardia and loss in body weight usually associated with thiamine deficiency. The basal diet of rats used for comparison contained sucrose, peanut oil, casein, marmite, and a salt mixture. The ration was modified by replacing all the sucrose by casein, thus raising the casein to over 72 per cent of the ration. The casein showed negligible amounts of thiamine by analysis.

The clinical features of the avitaminosis were studied by observations of growth records, electrocardiograms, and measurement of the "bisulfite-binding" substances in the urine. The results showed that the high protein diet prevented the bradycardia and loss in weight, although the increased excretion of bisulfite-binding substances was present in both groups. The measurement of these substances, however, cannot be considered to be specific for detection of thi-

amine deficiency, especially in groups of animals on different diets.

It is not clear from Banerji's report how many animals were used in each group on the diets. There is reason to believe from the graphic material presented that only 3 animals were used in each group. If so, the findings are seriously in need of confirmation. Apparently no attempt was made to compare the results with those which might be obtained on a high fat diet.

The findings of Quastel and Webley (*Biochem. J.* **35,** *192 (1941)*) are of interest in relation to the apparent thiamine-sparing action of protein. They showed that thiamine greatly accelerated the oxidation of acetic acid (by propionic acid bacteria), a type of intermediate which may be derived from protein or carbohydrate. Thiamine did not accelerate the oxidation of formic or butyric acid, these products being intermediates of fat metabolism but also derived from proteins. In thiamine-deficient bacteria, as in higher animals, products of carbohydrate metabolism such as glucose, lactic acid, glycerol, and propionic acid led to accumulation of pyruvic acid. It may be inferred therefore, that amino acids which in metabolism yield the latter substances would increase the thiamine requirement, and those yielding 1 and 4 carbon residues might not require thiamine for oxidation.

THE EFFECT OF WAR ON NUTRITION IN ENGLAND

Americans were greatly impressed by the favorable account of Sir John Orr on the state of nutrition in England in spite of wartime food restrictions. The lowering of infant mortality from prewar levels and other favorable nutrition reports testify to the results that can be obtained, even under tenuous conditions, when proper attention is paid to the needs and distribution of food. Dr. Sydenstricker, visiting England, has been quoted as being impressed by the general appearance of well-being and by the efficient job done by the Ministries of Food and Health in handling the food situation.

In contrast to this, a recent editorial in the British Medical Journal (*Brit. Med. J.* **II,** *640 (1942)*) charges the medical profession and the Administration with complacency regarding Britain's wartime nutrition. It is emphasized that a decrease or increase of dietary deficiency can only be determined by a comparison of present surveys with similar ones of the prewar period. A few such investigations lead to the conclusion that there is an increase in the occurrence of certain dietary deficiencies. The significance of this report for us is in the lesson it might teach America, now about to experience a decrease in its choice of foods. The dietary deficiencies which have emerged in England after three years of war might be the same which will first be encountered in America.

The extensive investigations of Dr. Helen Mackay revealed a considerable decrease in the hemoglobin level of women and children since the start of the war. Similar decreases have been reported among pregnant women and adolescents in Scotland and among medical students at Leeds. There are also several indications that the incidence of vitamin C deficiency is rising. Calculations of per capita ascorbic acid intake have shown an appreciable fall and this is reflected by vitamin C saturation tests. Dyke and co-workers (*Lancet* **II,** *278 (1942)*) have noted recently that many cases of pernicious anemia showed a poor response to liver therapy which was corrected by the simultaneous administration of ascorbic acid.

A deficiency of dietary factors during childhood is of particular importance since it may result in irremediable loss of growth. Milligan and Lewis-Faning have continued earlier studies on Glossop schoolchildren, and report a decreased growth rate in 11

year olds as compared to a similar prewar group. Endurance of the children was measured by the time a child could support himself from a bar or support an equal weight suspended from a pulley, and was found to be appreciably reduced in this period of observation.

In another report, Smith (*Brit. Med. J.* **II,** *440, (1942)*) cites his experience with rickets in a large orthopedic service during 1941 and 1942. He declares that there has been a 50 per cent increase in the number of rachitic patients seen, and a 15 per cent increase in the incidence of acute rickets, of a more severe type than formerly seen. Many cases were in babies 4 to 8 months of age who were breast-fed from mothers receiving no vitamin D. He believes that the present standard of vitamin D dosage is inadequate.

It is therefore suggested that a nutrition program must not only provide for adequate supply and distribution of food, but also must organize and correlate nutritional surveys that are well balanced between laboratory and clinical observations so that an accurate assessment of any change in public health may be made.

DIET AND GASTRIC LESIONS

Cancer of the stomach is one of the most common carcinomas in man but is rarely found in experimental animals. Fibiger (*Z. f. Krebsforsch.* **13,** *217 (1913)*) first succeeded in producing lesions in the forestomach of rats by infecting them with the parasite *Gonzylonema neoplasticum*. He thought the parasites were the responsible agents but later (*Ibid.* **17,** *1 (1920)*) emphasized that the diet of these animals was made up entirely of bread and water. Since that time numerous attempts have been made to relate gastric cancer to diet but the results have been almost as varied as the experimental conditions. Vitamin A deficiency, starvation, protein deficiency, and high fat diets are only a few of the conditions which have been found to produce gastric lesions in the rat. The literature on this subject has been reviewed by Klein and Palmer (*Arch. Path.* **29,** *814 (1940); J. Nat. Cancer Inst.* **1,** *559 (1941)*).

It has also long been suspected that irritation was an important factor in the development of neoplastic growths. Sugiura (*Cancer Research* **2,** *770 (1942)*) has attempted to combine an irritant with a deficient diet to produce gastric lesions in the rat. The four diets fed to young rats were polished rice alone, polished rice plus 5 per cent kieselguhr, brown rice, and brown rice plus carrots. The rats were maintained on these diets until they died (fifty to two hundred days) when gross and microscopic examinations were made. On the diet of polished rice epithelial hyperplasia of the forestomach and ecchymotic hemorrhages of the glandular portion of the stomach developed in 50 to 60 per cent of the animals. The addition of kieselguhr increased the incidence to 90 or 100 per cent. No lesions were found in the stomachs of the rats which received brown rice or brown rice plus carrots, but it should be mentioned that kieselguhr was not added to these.

Polished rice is well known to be deficient in protein, numerous vitamins, and minerals, and any one or a combination of factors may have been concerned in the results obtained. The interesting effect of added kieselguhr is thought to be due to its irritating properties. However, it should be borne in mind that it may have acted as an adsorbent and thus withheld certain essential dietary factors.

VITAMIN SYNTHESIS BY INTESTINAL BACTERIA

Intestinal bacteria are apparently of much greater importance to animal nutrition than was formerly suspected. It is recognized that vitamin K is synthesized by bacteria in the intestinal tract of man and most animals in quantities sufficient to meet their needs. Intestinal organisms isolated from man have been shown to synthesize thiamine, riboflavin, niacin, and biotin (*Nutrition Reviews* **1,** *4* (*1942*)). Herbivorous animals too appear to derive a significant part of their B-vitamin requirements from components synthesized by bacteria in their rumina.

Recent experiments further suggest that intestinal bacteria may synthesize B-vitamins that have not been clearly identified. Thus Black, McKibben, and Elvehjem (*Proc. Soc. Exp. Biol. Med.* **47,** *308* (*1941*)) found that the addition of sulfaguanidine to a basal diet free of the B-complex but supplemented with the available crystalline B-vitamins, resulted in a decreased growth rate of young rats. This effect was ameliorated when the basal ration was fortified with liver extract. Para-aminobenzoic acid prevented the inhibition of growth produced by sulfaguanidine, probably by antagonizing the bacteriostatic effect of the sulfonamide drug. The authors suggest that sulfaguanidine inhibits the growth of certain intestinal bacteria that normally synthesize essential unidentified factors of the B-complex. These factors, presumably, were present in the liver extract.

Daft, Ashburn, Spicer, and Sebrell (*Pub. Health Reports* **57,** *217* (*1942*)) also noted that rats fed a diet free of the B-complex but supplemented with 1 per cent sulfaguanidine and the crystalline factors of the B-complex, developed relative hypocellularity of the bone marrow, hyaline sclerosis, and calcification of the arteries. It cannot be safely assumed that this pathology was due to a deficiency of the unidentified vitamins rather than to a toxic effect of the drug.

It is evident that if intestinal bacteria do synthesize essential food substances which previously have not been recognized, then these factors should be present in the feces of animals as well as in liver or yeast. In order to test this possibility, Light, Cracas, Olcott, and Frey (*J. Nutrition* **24,** *427* (*1942*)) fed rats a basal diet free of the B-complex but supplemented with crystalline thiamine, riboflavin, niacin, calcium pantothenate, pyridoxine, inositol, choline, and a biotin concentrate. Some of the animals were also given sulfanilamide, sulfadiazine, or sulfaguanidine in amounts equal to 0.5 per cent of the ration. The addition of sulfonamide drugs to the diet resulted in a slower rate of growth which was corrected by the addition of yeast or yeast extract. Normal growth was also produced by addition to the diet of dessicated feces from animals which had been consuming the basal diet. On the other hand, addition of dried feces from rats which had been receiving the sulfonamide drugs were much less effective in supporting normal growth. Feces from animals which received sulfaguanidine were least effective, presumably because sulfaguanidine is the least readily absorbed of the three sulfonamides used and exerts, consequently, the greatest bacteriostatic effect on intestinal bacteria.

It seems likely, therefore, that there are certain unidentified essential food factors, probably components of the vitamin B-complex, that are present in yeast or liver and that are normally synthesized by the intestinal bacteria of rats. This last consideration probably explains why the existence of these factors was not discovered until a method became available for decreasing the number or type of intestinal microorganisms.

Light and associates call attention to the fact that rats have a large cecum which may serve as a "fermentation vat" in which the synthesis of these essential factors may occur. Other species of animals, like man and the dog, are not so equipped. Nevertheless it has already been demonstrated that one of the vitamins, biotin, is provided to man in larger quantities by the intestinal bacteria than by the diet (*Am. J. Med. Sci.* **204,** *856 (1942)*) and it is possible that man may not develop deficiencies of pantothenic acid, pyridoxine, biotin, inositol, and other vitamins commonly because these essential food substances are normally provided by microorganisms in the intestinal tract.

STORAGE OF VITAMIN A IN THE BODY

An interesting account of some investigations on vitamin A deficiency has been reported by Wald, Brouha, and Johnson from the Fatigue Laboratory of Harvard University (*Am. J. Physiol.* **137,** *551 (1942)*). The principal feature of this report is a study of the effects of vitamin A on the ability of young men to perform muscular work. These investigators found, under the conditions of their experiments, no relation between vitamin A and muscular exercise, but there is general interest in their observation that the stores of vitamin A can be drawn upon for extended periods without replenishment from dietary sources.

The Harvard investigators placed 5 young men on a diet low in vitamin A for a period of about six months. These men were all college students in good health. Before the experiment was undertaken each subject received for thirty days 75,000 I.U. of vitamin A daily. Thus it could be assumed that the vitamin A reserves of the subjects were then saturated. The diet which these persons subsequently consumed in the period of vitamin A deficiency consisted of ordinary foods, except for the elimination of colored vegetables and fruits, dairy products except skimmed milk, and liver and kidney. These are the foods which supply vitamin A or its precursor, carotene. The total vitamin A content of the diet was kept within 100 I.U. or less each day. The minimum requirement of vitamin A for protection against obvious signs of serious deficiency is considered to be about 1500 I.U. daily. If the vitamin A is supplied entirely in the form of carotene, the minimal requirement is considered to be about 3000 I.U. The daily allowance of the Food and Nutrition Board of the National Research Council is 5000 I.U., and this value is based in part on the assumption that usually about two-thirds of the vitamin A is secured from vegetable sources as carotene and about one-third from animal sources as vitamin A itself.

A check on the diet was furnished by examinations of a sample of feces each week for carotene and xanthophyll. It was found that within a week after beginning the deficient diet the amounts of these carotenoids in the feces had fallen to about 1 per cent of the values observed when the subjects were ingesting their ordinary diets. Because foods which supply vitamin A also are good sources of other dietary essentials it was considered desirable to supplement the vitamin A-low diet with brewers' yeast (to supply thiamine and riboflavin), ascorbic acid, dicalcium phosphate, a preparation of iron and copper, and about 1300 U.S.P. units of vitamin D in the form of irradiated ergosterol. The subjects maintained weight during the experimental period and performed the usual activities of college students.

Measurements of the amounts of vitamin A in the blood plasma were made at weekly intervals. The carotene content also was determined. It is particularly interesting to note that the amount of vitamin A in the plasma, which was initially high, remained

high throughout the entire deficiency period. These high values ranged from 1.57 to 2.97 I.U. per ml. of blood plasma. Apparently the stores of vitamin A in the liver were sufficient to maintain the amount of vitamin A in the blood plasma at high levels for several months. The content of plasma carotenoids, however, dropped quickly from normal levels of 1 to 2 micrograms per ml. to no more than 0.5 microgram per ml. In some instances the amount of carotenoid was so small that it could not be measured accurately, this fact of course indicating a rigid dietary control by the subjects of the experiment.

In view of the observation that the plasma content of vitamin A remained high, it is not surprising that the visual threshold in 3 subjects remained constant and minimal throughout the experiment. In 2 subjects, however, there was some indication of vitamin A deficiency as shown by a rise in visual threshold. This rise was slow in rate and moderate in degree.

In the study of the effects of the vitamin A deficient diet on muscular exercise, the standard treadmill test of the Fatigue Laboratory was used. This test consists of walking for fifteen minutes at 3.5 miles per hour on an 8.6 per cent grade followed by a rest of ten minutes, then a run to exhaustion or up to five minutes at 7 miles per hour on an 8.6 per cent grade followed by a rest of twenty minutes. The measurements consisted of determinations of the heart rate and blood pressure while seated before the run, continuous measurements of the heart rate during and after the run, ventilation and oxygen consumption during the walk and run, and determinations of the lactic acid content of the blood during the walk and after the run. The observations were made on the subjects after they had been on a deficient diet for from three to four and a half months and again about six weeks after the conclusion of the experiment when they were receiving a normal diet supplemented with vitamin A. No significant differences in the ability of these men to perform moderate and heavy muscular exercise were observed.

Only one man complained of abnormal fatigue or lassitude during the period of deficiency, and he also exhibited the greater rise in visual threshold. Although he performed no better on the treadmill after returning to a normal diet, he reported that he felt much better. The other subjects likewise claimed to feel better on the return to a normal diet, although the tests showed no significant improvement.

These experiments duplicate the experience of others who have found that the human being whose stores of vitamin A are built up by administration of high dosages of this vitamin can withstand the effects of a vitamin A-poor diet for as along as several months. Steininger, Roberts, and Brenner (*J. Am. Med. Assn.* **113,** *2381 (1939)*) demonstrated that young women who had received an adequate diet could maintain essentially normal values for vitamin A in the blood plasma for as long as four months. Such observations are of value in connection with problems of feeding people when circumstances demand that they be maintained on a limited variety of foods. Those who are interested in the philosophic aspects of science could find here an example of adaptation to nature. No doubt man formerly obtained his vitamin A mostly during the summer months, in accordance with the seasonal production of carotene (vitamin A) in plants. While it is desirable to secure one's quota of vitamin A each day, yet it is good to know that, if the vitamin A stores are high, no nutritional catastrophe is likely to develop if one misses his allowance of this dietary essential now and then.

PROTEIN VALUE OF SOYBEANS, PEANUTS, AND COTTONSEED

The present worldwide war forebodes a general shortage sooner or later of protein foods, especially of meat, milk, fish, and eggs which furnish proteins of high nutritional value. There is thus an understandable interest in the proteins of plant foods which, unlike most animal foods, can be produced in a single year. The cereal grains fulfill the requirements for a quickly grown plant food which keeps well and has a fair protein content, but these products already are furnishing a significant amount of protein in the diet. To replace our dwindling sources of animal proteins it will be necessary to make the most efficient possible use of cereals, especially wheat, and to begin to utilize plant sources in addition to the cereal grains, particularly those few plant foods which contain large amounts of protein of excellent nutritional value as shown by their amino acid composition. Products made from soybeans, peanuts, and cottonseed are eminently suitable from this point of view. Like most of the oily seeds, these contain proteins of high biologic value. Their use as food has been confined almost entirely to specialty items, however.

Cottonseed contains a toxic substance (gossypol) which must be destroyed or inactivated by heat before the product is suitable for human consumption. Suitably processed cottonseed flour has been marketed by some Texas firms for a number of years, but it has been used chiefly, it is understood, as an ingredient of certain commercial baked goods. The potential value of soybean protein is illustrated by the use to which this product has been put in the preparation of so-called soybean milks for infants who are unable to tolerate cow's milk. Such usage is complicated, however, by the fact that some infants do not tolerate soybean well, and may develop diarrhea; this difficulty is recognized by continuing research in the development of new soybean preparations and also by the substitution of amino acids themselves as a source of protein in the diet of the infant. Peanut flour appears to have received little attention as a possible item of food.

Because of renewed interest in the proteins of soybeans, peanuts, and cottonseed there is a special timeliness in the recent report by D. Breese Jones and J. P. Divine of the Protein and Nutrition Research Division of the Bureau of Agricultural Chemistry and Engineering. (Mimeographed abstract of a paper presented at the annual meeting of the American Soybean Association held at Lafayette, Indiana, September 15 to 17, 1942; also published in the *Soybean Digest*, September 1942.) These investigators not only compared patent flour with whole wheat flour but they also compared the results obtained with peanut flour, cottonseed flour, and soybean flour as the sole source of protein. In addition experiments were performed to determine the value of adding 5, 10, and 15 per cent of peanut, cottonseed, and soybean flours, respectively, to patent flour. The results have practical possibilities of great significance at the present time.

White rats were used as the experimental animals. The flour being studied was mixed in the diet in proportions that would supply 9.1 per cent of total protein, this low level being taken because it would emphasize differences in amino acid composition of the respective proteins. Autoclaved starch was included in the diet as a diluent. All experimental rations were made to contain the same amount of fat, about 8 per cent, supplied partly by the natural oils in the products and partly by corn oil. The rations also contained a complete salt mixture, 2 per cent cod liver oil, and the following crystalline vitamins in appropriate amounts: thiamine, riboflavin, pyridoxine, calcium pantothenate, niacin, and choline. The results were expressed in terms of average gain in body weight over a period of six weeks.

The animals fed patent flour gained 19 g., those fed whole wheat flour, 36 g. With peanut flour as the sole source of protein the gain was 75 g.; with cottonseed flour, 85 g.; and with soybean flour, 87 g. The high biologic value of the seed proteins is apparent although here again there were variations in the food consumption of the animals in the different groups. The value of small additions of these other protein foods to white flour was shown clearly. For example, when 5 per cent soybean flour was added to patent flour the gain was 39 g. in six weeks. With 10 per cent soybean flour the gain was 75 g., and with 15 per cent soybean flour it was 93 g. The addition of like amounts of cottonseed flour or peanut flour produced comparable results. The authors mention the possibility that a mixture of all three materials might give even better results than were obtained by the addition of a single substance.

Breese Jones attributes the difference in biologic value of the proteins to the differences in lysine content. This amino acid, which is essential for growth, is present only to the extent of about 2 per cent in gluten, the principal protein of wheat. The mixed proteins of cottonseed contain about 4 per cent of lysine while those of peanuts contain about 5 per cent of this amino acid. Glycinin, which is a principal protein in the soybean, contains about 9 per cent of lysine. Of course, as the investigators have pointed out, there is a possibility that other amino acids may be concerned with the results obtained.

The soybean, peanut, and cottonseed flours used in these experiments were commercial products specially produced for human consumption. The patent flour and the whole wheat flour were milled from the same supply of grain.

It may be recalled that during the last war chopped straw and other indigestible materials were added to flour in Germany with a view to extending the available food supply. This practice was opposed by Professor Max Rubner, perhaps the outstanding German physiologist of the day, who pointed out that the presence of so much indigestible material might have some transient benefit in filling the stomach and thus relieving hunger contractions but in the long run it would prove detrimental because the indigestible material would interfere with digestion and absorption of the flour and other foods. Experiments showed this to be true and since that time it has been shown repeatedly that an increased amount of roughage in the diet leads to the formation of bulkier stools which contain a higher proportion of unabsorbed and undigested materials. From the evidence obtained in many experiments it appears that the amount of indigestible material in whole wheat flour is of no practical consequence. But the problem of securing an adequate supply of protein remains an important one. Would it not be well to consider the addition of small amounts of soybean flour or peanut flour to the flour that is used for making bread? The authors state that bread made from white flour containing as much as 10 to 15 per cent of soybean or peanut flours is scarcely distinguishable in taste or appearance from bread made from white flour alone. Other investigators are not so confident that the product would be acceptable. Apparently the practicability of additions of cottonseed flour has not been studied.

The factor of palatability in consumer acceptance of a product is important, as any food manufacturer can verify. Should bread made from flour containing 10 per cent of soybean flour prove to be acceptable to consumers, it would seem that such a product would be of tremendous value, especially in providing an adequate supply of good quality protein for people in low income groups. Now that much of the dried skimmed milk formerly used in the commercial bread making industry is being allocated for other purposes, bakers generally might give consideration to the possibility of substituting soybean flour. Much investi-

gative work should be done, however, before such a step is advocated. A committee of the Food and Nutrition Board of the National Research Council already is giving serious consideration to the various possibilities presented.

THIAMINE AND POTASSIUM DEFICIENCY IN THE RAT

Potassium deficient rats, mice, and swine develop myocardial necroses as well as renal tubular lesions. Necrosis of the myocardium has also been described in thiamine deficient pigeons, dogs, foxes, and swine. Reasoning that if these two deficiencies were combined the myocardial lesions might be more extensive, Follis (*Bull. Johns Hopkins Hosp.* **71,** *235 (1942)*) developed simultaneous thiamine and potassium deficiencies in a group of rats, with results that were contrary to his expectations.

Sixteen animals were made deficient in both potassium and thiamine, 7 in thiamine alone, 17 in potassium, and 6 animals were used as controls. Five of the potassium deficient animals were restricted in their food intake over a two week period, to test the effects of inanition. These animals developed the same lesions as the other potassium deficient animals, indicating that inanition was not a factor in complicating the interpretation of the pathology observed. The gain in weight of the control group was greatest, followed by the thiamine deficient, potassium deficient, potassium and thiamine deficient, and the potassium deficient group on restricted diet, in that order.

All the rats in the potassium deficient group showed extensive necrotic cardiac lesions, while only one animal in the group deficient in both potassium and thiamine developed heart lesions, and these were minute. Three of the rats in this group were given 5 mg. of thiamine after thirty-nine days on the doubly deficient diet. One died suddenly and showed no cardiac changes, the other two exhibited many fresh lesions when autopsied three days later. None of the animals deficient in thiamine alone showed any cardiac, renal, or skeletal muscle lesions on autopsy, but rats in both of the thiamine deficient groups showed physiologic cardiac effects in the form of slowing of the heart rate.

The animals deficient in both thiamine and potassium developed the renal lesions characteristic of potassium deficiency. All but two of the group showed in addition necrotic lesions of the skeletal muscle, which were found only in this group.

Any speculation on the mechanism of the protective action of thiamine deficiency upon the heart muscle of the potassium deficient rat must at this time be of conjectural nature. It is not uncommon to find, however, that in human nutritional deficiencies, such as pellagra, the existence of multiple deficiencies often results in obscurity or retardation of the symptoms characteristic of each. Under these conditions treatment with only one of the factors often clarifies the deficiency symptoms of another. Perhaps the bradycardia which is the constant accompaniment of thiamine deficiency in the rat may reduce the metabolism of the heart muscle and its need for potassium, as Follis suggests.

It is of interest that bradycardia occurs characteristically with thiamine deficiency in the rat and the pigeon, but not in the dog. In human beriberi, tachycardia is a characteristic finding, yet myocardial necroses as such are rarely, if ever seen.

Follis states that the muscular dystrophy observed in the rats deficient in both thiamine and potassium is similar to that described in vitamin E deficiency in rats and other animals. The published account of his experiments offers no reason, however, to suspect vitamin E deficiency in his animals.

EFFECTS OF ANTACIDS ON IRON RETENTION

The iron requirement of patients with chronic ulcer of the stomach or duodenum should receive special attention as indicated by a report of animal experiments by Freeman and Ivy (*Am. J. Physiol.* **137,** *706 (1942)*). It generally has been held that the nutritional requirements of ulcer patients are the same as those for persons who enjoy excellent health; the difficulty has been in meeting these requirements with the somewhat limited number of foods permitted. Items that are likely to be irritating to persons with ulcer, and which are forbidden, include coarse cereal foods such as whole wheat which contains appreciable amounts of crude fiber; sugar in concentrated forms; foods which contain appreciable amounts of organic acids, such as certain fruits (particularly citrus fruits) and vinegar; and accessory items such as spices and condiments, tea, coffee, and tobacco. Because whole grain cereals are prohibited it may be difficult to formulate a diet that contains sufficient thiamine. When fruits are restricted the intake of vitamin C also might not be sufficient. In such cases it becomes highly desirable to supplement the diet with suitable vitamin preparations though this is seldom done in most ulcer clinics or wards. The treatment of peptic ulcer usually involves also the administration of alkalies for reducing the acidity of the gastric contents. The report of the Northwestern University investigators shows that the administration of the usual gastric antacids may interfere with the absorption of iron from the intestinal tract, and the iron requirement of ulcer patients therefore may be higher than that of healthy persons.

Should there be bleeding from the ulcer there is a further loss of iron from the body, and, as is well recognized by clinicians, severe anemia may develop. At Minnesota, Flink and Watson (*J. Biol. Chem.* **146,** *171 (1942)*) with their new method for the quantitative estimation of hemoglobin and related pigments in the feces, report that a patient with a bleeding peptic ulcer lost in one day, by way of his intestinal tract, 27 g. of hemoglobin, which is equivalent to more than 200 ml. of blood.

The experimental procedure employed by Freeman and Ivy involved the restriction of young albino rats to a diet of milk until they were markedly anemic. Each animal was then given 0.25 mg. of iron as ferric chloride and small amounts of salts of manganese and copper. Some of the animals also received an alkali in appropriate amounts, based on the dosages ordinarily employed in the treatment of human beings. The antacids studied were aluminum hydroxide, aluminum phosphate, calcium carbonate, and magnesium trisilicate. Recovery from the induced anemia was followed by determinations of hemoglobin concentration of the blood at weekly intervals; and at the end of the experimental period the animals were killed and analyzed for total iron content. It was shown that both calcium carbonate and aluminum hydroxide markedly reduce the amount of iron retained by the animal body. Magnesium trisilicate reduced the retention of iron to a slight degree and aluminum phosphate had no demonstrable effect. The investigators used a fairly large number of animals for each substance studied; the experiments were well controlled and the differences in response were shown to be statistically significant.

The authors suggest that the ratio of calcium to phosphorus in the diet may be a determining factor and there are reports in the literature which indicate that a high calcium to phosphorus ratio of the diet results in a lower assimilation of iron. Another possible factor is the degree of acidity in the stomach, aluminum phosphate permitting a more acid reaction than the other antacids. These possibilities afford some interesting opportunities for further

study but, regardless of the complex reactions which are no doubt involved, it is clear that the results suggest the desirability of administration of iron salts to ulcer patients who are maintained on alkali therapy for any appreciable period of time.

FLUORIDES IN WATER AND MILK AND THE INCIDENCE OF DENTAL CARIES

Fluorides, fed in small amounts, are beneficial to the teeth of animals. Both in human beings and in rats it has been shown that the fluorine content of the enamel of sound teeth is higher than that of carious teeth. There is dispute however, as to whether the fluoride effect is due to incorporation of fluorine in the teeth or to inhibition of bacteria in the mouth. These studies have not yet justified the addition of fluoride to drinking water on a widespread scale since this substance is relatively toxic and the amount necessary for a beneficial but nontoxic effect is not well established for man. Therefore surveys of the population to correlate dental caries and the fluorine content of drinking water or of the milk supply are of great value. Two such surveys among children in various localities of the country have been recently published.

Dean and associates (*Pub. Health Reports* **56,** *761 (1942); Ibid.* **57,** *1155 (1942)*) have studied this problem in relation to the fluoride content of drinking water. In their first study on 2832 children in 8 suburban Chicago communities it was found that the "continuous use of a domestic water, the fluoride content of which was close to the minimal threshold of endemic dental fluorosis (mottled enamel) was associated with a relatively low dental caries experience. For example, at Aurora, Illinois, where the domestic water supply contained 1.2 p.p.m. of fluoride and where a relatively low dental caries prevalence was recorded, mottled enamel as an esthetic problem was not encountered. Strong presumptive evidence suggests that the factor or factors responsible for this increased freedom from dental caries is the fluoride content of the domestic water; the fact that it was operative at concentration levels so low that mottled enamel ceased being an accessory complication was a finding of first importance." In 3 of the 8 suburban communities where the water supply was low in fluoride the prevalence of dental caries was relatively high.

It therefore appeared to Dean and associates that fluoride levels under 1 p.p.m. might influence the incidence of dental caries and they undertook to study this problem in 13 communities, located in Illinois, Indiana, Ohio, and Colorado, whose water supplies contained fluoride in low concentration. These latter studies included 4425 children. "The groups examined generally represent all 12, 13, and 14 year old white public schoolchildren continuously exposed to the variable under investigation (the public water supply)."

The problem of vitamin D deficiency was considered by comparing the incidence of dental caries in the 13 cities with the per cent of "clear days" (the number of "clear days" for each community was determined by adding the number of "clear days," as defined by the Weather Bureau, and half the total number of partly cloudy days) experienced by these cities over a 15 year period. No correlation was found to exist between the number of clear days experienced by a community and the incidence of dental caries. The percentage of children examined in the various communities who showed dental caries ranged from 72.2 to 100 per cent with 8 of the communities showing an incidence of over 94 per cent. The number of permanent teeth showing dental caries ranged from 2.36 to 10.37 per child. Of the 4425 children studied in the 13 cities, 2859 living in the communities whose public water supply contained less

than 0.5 p.p.m. of fluoride showed about nineteen times as much proximal surface caries in the four superior permanent incisors as was observed in the 1566 children living in the cities where the water supplies contained from 0.6 to 2.6 p.p.m. of fluoride. In these same two groups of children, the "first permanent molar" mortality rate for those living where the water supply contained less than 0.5 p.p.m. of fluoride was about four times as high as that observed in the children using water containing more than 0.5 p.p.m. of fluoride (0.66 and 0.156 per child, respectively).

Severe degrees of mottled enamel (1.5 per cent of the children) were found in only one community, Colorado Springs, Colorado, where the fluoride content of the water was 2.6 p.p.m. Moderately severe and mild degrees of mottling occurred in communities where the fluoride content of the water was 1.9 to 2.6 p.p.m. Only 0.8 to 2.0 per cent of the children in 4 other communities showed mild mottling where the fluoride content of the water was 0.58 to 1.2 p.p.m.

The authors include a chart showing the variations in dental caries with fluoride content of the public water supplies for the 21 communities included in their two studies. This chart reveals that the curve of incidence of dental caries begins to rise when the fluoride content of the domestic water supply is below 2.0 p.p.m., with the gradient becoming much steeper when the fluoride content is below 1.0 p.p.m. (The water supply of two communities studied by these workers contained fluoride in concentrations between 0.5 and 1.0 p.p.m.) The lowest incidence of dental caries found by Dean and associates in the 21 cities studied was 2.36 per child in an area where there was a drinking water fluoride content of 1.9 p.p.m. Hence the most effective concentration of fluoride in drinking water, from the standpoint of the prevention of dental caries, appears to be approximately 2.0 p.p.m.; but at this concentration, mottled enamel of mild to moderate degree can be expected to occur in a small percentage of the habitual users of the domestic water supply.

In another study, McClendon, Foster, and Supplee (*Arch. Biochem.* **1**, *51* (*1942*)) found an inverse relation between the incidence of dental caries in city schoolchildren and the fluorine content of the milk supply. Children in the age group of 12 to 14 years were chosen for simplification of statistical analysis. Locations were divided by parallels of latitude, and in the final analysis the incidence of caries, expressed as the average number of carious teeth per child, was compared to the fluoride content of the milk.

In communities where the number of carious teeth per child averaged 4 to 6, 22 of 26 towns had a milk supply which averaged only 5 to 14 micrograms per 10 ml. of milk; the other 4 towns (with a lower caries incidence) had a milk supply which averaged 15 to 29 micrograms per 10 ml. of milk.

Such surveys leave little doubt as to a correlation of fluoride intake and incidence of dental caries, but because of the small margin between the effective fluoride concentration and that producing mottled enamel, and the fact that many other factors are involved in the picture, further study must be given to this subject before addition of fluoride to public water or food supplies can be considered good public health practice.

OPHTHALMOLOGY AND VITAMINS

Night blindness and xerophthalmia are two of the oldest afflictions known to man. Although it was not until the second decade of this century that vitamin A deficiency was acknowledged to be related to both these conditions, there is evidence that the

Egyptians recognized a dietary etiologic factor as early as the nineteenth century B.C. It was common practice in both Egyptian and early Greek medicine to recommend raw liver in the treatment of these afflictions. The eye has been also long regarded as an important mirror for many systemic conditions such as jaundice, arteriosclerosis, hypertension, diabetic ketosis, bacteremia, hemorrhagic diatheses, anemia, and the common cold. Examination of the eye may be used for diagnosing some intracranial lesions and the eye is subject to a large number of localized lesions. No medical examination is considered complete without a careful study of the eye. It is rather surprising then that the abundant literature of the last few years on vitamins and nutritional deficiency diseases does not include more reports of investigations on the effects of nutritional deficiencies upon the eye.

The major effects of vitamin A deficiency upon the eye are at present well known. Practically all current work on this subject is in relation to methods for diagnosis of early or low grade deficiency. Butt includes an extensive bibliography in his review of the fat soluble vitamins (*J. Am. Med. Assn.* **120,** 1030 (1942)). Kruse and collaborators described a superficial vascularizing keratitis associated with ariboflavinosis and cured by treatment with riboflavin (*J. Am. Med. Assn.* **114,** *2437 (1940); Pub. Health Reports* **55,** *157 (1940)*). It appears to be fairly well established that external ocular muscle palsies characteristic of Wernicke's encephalopathy are caused by thiamine deficiency. There is reason to believe that the optic neuritis and atrophy of alcohol addicts and some inveterate cigar smokers, may both be caused by an associated thiamine deficiency. More intensive study of these conditions is indicated. In addition, the ophthalmologic literature during the past year has included a number of articles on the role of nutrition in the production and cure of a variety of ocular diseases. Several of these are worthy of particular mention, not because they show conclusively a causative relationship between any one vitamin and a specific disease, but because of the possible fields for investigation that they suggest.

Cosgrove and Day (*Am. J. Ophth.* **25,** *544 (1942)*) treated 28 patients, who had corneal disease, with riboflavin. Five of 6 subjects with interstitial keratitis associated with congenital syphilis, showed definite improvement in vision, and on examination with the corneal microscope, one showed slight improvement. One marginal ulcer associated with acquired syphilis healed in six days with two intramuscular injections of 15 mg. of riboflavin. Six cases of keratitis of undetermined etiology, and presumed to be possible cases of ariboflavinosis, improved on injection of 8 mg. of riboflavin daily for a minimum period of one month. One of these subjects had a recurrence of the keratitis when the riboflavin supplement was discontinued. Only one of 5 patients with keratoconjunctivitis showed marked improvement and one showed no improvement after twenty-five days of therapy. Two cases of allergic conjunctivitis showed no improvement; one case each of keratitis associated with cataract, marginal keratitis, phlyctenular keratoconjunctivitis, ulcerative keratitis, and phlyctenular keratitis improved with riboflavin therapy; and one case each of linear keratitis, ulcerative keratitis, and punctuate keratitis remained unimproved.

Aside from the support which the work of Cosgrove and Day gives to the concept of an ariboflavinotic keratitis, this study is of interest because of the results reported for the treatment with riboflavin of 6 cases of interstitial keratitis associated with congenital syphilis. It is not certain that the improvement of the keratitis was due specifically to riboflavin, since 5 of the 6 subjects received concurrent antisyphilitic therapy. Four patients, however, whose treatment with antisyphilis drugs and with riboflavin

overlapped, had failed to show any obvious improvement in the keratitis after a two to five month period of antisyphilitic treatment alone, and one patient who showed a marked improvement with riboflavin administration had previously discontinued an unsuccessful period of specific antisyphilitic therapy. The authors state that "cases of interstitial keratitis associated with hereditary syphilis responded much more rapidly when riboflavin was administered than when antiluetic treatment alone was given." Granting that these subjects were helped by riboflavin therapy, what then was the etiology of the keratitis and the mode of action of the riboflavin? Is it possible that the keratitis in these subjects was due to ariboflavinosis and that the syphilis was merely a coincidental finding? If so, how many cases diagnosed as syphilitic keratitis were in reality ariboflavinotic? In ophthalmology, as in other branches of medicine, the reputed benefits of vitamin therapy are often based on too few cases, on a purely impressional basis on the part of the investigator, or solely on subjective feelings of the patient.

Wetzel (*Am. J. Ophth.* **25,** *409* (*1942*)) cites a case reported by Nitzulescu and Triandof (*Brit. J. Ophth.* **21,** *654* (*1937*)) in which administration of 6 mg. of thiamine, divided over a four day period, to a patient with dendritic keratitis and superficial corneal erosions, following control of a gonorrheal conjunctivitis, was associated with complete clearing of the cornea in nine days. It is impossible to generalize from a single case or to accept the explanation of these latter workers "that the nerves injured by the localization of the herpetic virus benefit from a supplement of vitamin B_1 just as diseased myocardium benefits from the action of digitalis."

Yudkin (*Am. J. Ophth.* **25,** *284* (*1942*)), in a general article on vitamins in ophthalmology, cites several favorable reports on the use of specific vitamins in the treatment of ocular diseases, such as the use of large amounts of ascorbic acid in the treatment of hemorrhages in the vitreous and hemorrhagic chorioretinitis. He is enthusiastic about the need of maintaining the patient with ophthalmologic disorders in the best possible nutritional state. ("I usually tell the patient that vitamins should always supplement a well-balanced diet.") The recommendation of fortifying an already well-balanced diet is not sound nutritional practice, and has produced considerable resistance by many, including physicians, to acceptance of better established nutritional facts. For nearly nine years Dr. Yudkin has been treating lenticular changes in elderly patients primarily by correcting dietary habits. He has observed that, "if the protein content is about normal, and the diet is sensible, the vacuoles underneath the lens capsule seem to disappear and the visual acuity improves." The improvement of vision and lens changes due to dietary treatment has not been generally accepted however among ophthalmologists and is best regarded in the light of Yudkin's own conclusion: "I can say with all frankness that my elderly patients feel much better with this general care; some of them return to work and others seem to gather a new lease on life. If this dietary regime does not eliminate the early lens changes, it improves the general health of this group to the extent that it should be used more frequently."

Moose (*Am. J. Ophth.* **25,** *194* (*1942*)) does not attempt to treat any ocular disease nutritionally, but points out that patients who come to the ophthalmologist for glasses commonly complain of one or more of twelve general symptoms: headache, fatigue, "touches of rheumatism," constipation, vague digestive complaints, nervousness, poor appetite, dizziness, disturbed sleep, feeling cold, skin disturbances, and cold or sweaty hands. Many of these patients with refractive errors have noticed that, when the general symptoms are worse, the eye symptoms are worse and they are, therefore, apt

to go to the ophthalmologist for glasses as an initial step in their search for relief. Naturally, adequate refraction does not always result in relief of general symptoms. Moose became interested in the dietary habits of his patients and obtained detailed diet histories on 100 of them. Twenty-eight per cent of the patients with refractive errors were found to consume almost no milk. Deficiency of animal protein from low intake of milk, cheese, eggs, and meat was general. Nearly half the total calories ingested by the members of this group came from "bread, sweets, and pastries from white flour and cane sugar."

To 50 of the patients (treated group) glasses, corrected diets, and vitamin concentrates were given; to the other 50 patients, used as controls, only glasses were prescribed. All subjects were again examined one or two months later. There was a marked decrease in frequency and severity of all symptoms, except constipation, in the treated group, while in the control group glasses had a decided effect only upon incidence and frequency of headaches. Even in relation to headaches, the treated group fared much better than the controls.

It should be noted that any change in the general symptoms treated by Moose could be judged only subjectively and consequently must be considered in the light of such comments on the part of the investigator as: "If an improved diet is of benefit to one organ, it must be of benefit to all other organs, hence of value in all eye therapy." This statement is clearly overenthusiastic and is not supported by any facts. Moreover the scientific or clinical value of such a study must be weighed on the basis of the doubtfully significant report in this paper that 9 out of 14 patients having high blood pressure were also improved by the dietary treatment.

The greater need for application of modern ophthalmologic tools and controlled experimentation is obviously necessary for sound advances in the relation of nutrition to eye disorders.

DIETARY PROTEIN AND RESISTANCE TO INFECTIOUS DISEASE

If antibodies are specifically modified globulins but dependent on the same factors that control normal globulin production, then a dietary protein deficiency can be expected to affect antibody production adversely and lead to decreased resistance of the body to infectious disease. This thesis has been advanced and supported by Cannon (*J. Immunology* **44,** *107 (1942)*). He believes that antibodies are formed intracellularly during the synthesis of globulin and that antigens are the stimuli which "give rise to a specific alteration in the reaction capacity of the tissue cells." In support of this theory he states that such unrelated stimuli as nonspecific protein injections, hemorrhage, hyperthermia, and "possibly even conditioned reflexes" may cause a reappearance in the blood of antibodies to previously injected antigens. He also cites the studies of Sabin (*J. Exp. Med.* **70,** *67 (1939)*) who observed that, following the injection of a dye-protein into rabbits, antibodies appeared in the blood at a time when the dye-protein was no longer visible in the macrophages of the liver but when these cells were partially shedding their surface films. Sabin concluded that Kupffer cells normally produce globulin and that "antibody globulin represents the synthesis of a new kind of protein under the influence of an antigen."

From the standpoint of protein synthesis, a number of investigators have demonstrated that a dynamic equilibrium exists between tissue and plasma protein, and that when dietary protein is inadequate either in quality or quantity, there is a decrease in

the body's reserve stores of "plasma protein" (both albumin and globulin) and finally a lowering in the plasma protein content.

These two lines of evidence lead to the possibility that inadequate dietary protein might lead to decreased resistance to infectious disease through lessened antibody production. There is some direct evidence for this hypothesis. Whipple noted that plasma depleted dogs are even more susceptible to infection than anemic ones. It is known that young animals do not form antibodies comparable in quantity or quality to those of adult animals and this may be related to the characteristically lower serum protein levels in young animals. Theobald Smith and associates observed that newborn calves, which are deficient in globulins, are unusually susceptible to colon-bacillus septicemia, and that generalized infection can be prevented by the administration of colostrum or the intravenous injection of cow's serum. Cannon states that experiments in his laboratory show that "rabbits whose protein reserves have been reduced by plasmapheresis and a low protein diet (carrots) show a definitely lessened capacity to produce antibodies."

It is well known that protein shortage (though nonspecific as a deficiency in most cases at least) occasioned by war, results in fertile breeding ground for epidemics of infectious disease. It is true of course that under such conditions there is likely to exist a deficiency of other dietary factors which may bear an equally important relationship to resistance to infectious disease, as well as a breakdown in the normal system of health protection. In England, however, according to Frazer (*Am. J. Pub. Health* **32,** *1319 (1942)*) there have been no "epidemics of major infectious diseases" in three years of war despite the influx of many refugees and soldiers, the migration of people within the country, and the sporadic breakdown in sanitary facilities in bombed towns and cities. The prevention of epidemic infections in England may well be related to maintenance of adequate nutrition despite the war. A less happy future is predicted by Cannon for the starving peoples of conquered European countries.

DEHYDRATION AND VITAMIN STABILITY

Increased production of dehydrated foods for war purposes has placed new emphasis on the need for more authentic information regarding the nutritive value of these products, as compared with the fresh foods from which they were made. Until comparatively recent months it was possible to paraphrase Mark Twain's famous statement about the weather by remarking that everyone talks about vitamin stability during and subsequent to commercial dehydration but few investigators have done much about it.

To be sure, research workers have been interested in factors affecting vitamin stability and many papers have been published describing laboratory experiments dealing with heat treatment of many types of foods for man and animals. However, with rapid development of new and improved methods of commercial dehydration, research work on vitamin stability in dehydrated foods has not kept pace with industrial developments.

As early as 1918 Delf and Skelton (*Biochem. J.* **12,** *448 (1918)*) pointed out that speed of dehydration plays an important role in preservation of vitamin C during drying of cabbage. Researches similar to those published by Ellis, Steenbock, and Hart (*J. Biol. Chem.* **46,** *367 (1921)*) led to studies which proved that enzyme action and intercellular oxidation play an important part in destruction of vitamin C during slow dehydration. It soon became evident that enzyme inactivation and re-

duction of opportunity for oxidative destruction must be considered and controlled if appreciable vitamin C is to be retained in a desiccated food product. Similar observations were made by Russell (*J. Biol. Chem.* **85,** *289* (*1929*)) who noted that alfalfa hay, dried artificially in a commercial hay drier, was about seven times as potent in vitamin A as the same hay dried and cured by ordinary field methods. Hauge and Aitkenhead (*J. Biol. Chem.* **93,** *657* (*1931*)) showed that the destructive effect of field drying and curing of hay was largely enzymatic in character and that carotene was preserved in artificial drying of hay because of the enzymic inactivation by heat.

Reports by Jephcott and Bacharach (*Biochem. J.* **15,** *129* (*1921*)), Hess, Unger, and Supplee (*J. Biol. Chem.* **45,** *229* (*1920*)), and Cavanaugh, Dutcher, and Hall (*Ind. Eng. Chem.* **16,** *1070* (*1924*)) showed that although powdered milks varied in their content of vitamin C, it was possible to preserve significant amounts of the vitamin if oxidative destruction could be avoided. Work at California by Morgan and Field (*J. Biol. Chem.* **82,** *579* (*1929*)) emphasized the stabilizing effect of sulfuring dehydrated fruits so far as the carotene content was concerned. These and many other experiments conducted by older methods of vitamin assay led to a better understanding of the problems which confronted the food technologist, but more information was needed regarding the effect of present day dehydration processes on vitamin stability as measured by the latest technics.

Representative of the last mentioned types of studies are those reported by Chace, of the Executive and Operating Committee on Dehydration, Bureau of Agricultural Chemistry and Engineering, U. S. D. A., Western Regional Research Laboratory, Albany, California (*Proc. Inst. Food Tech. p. 70* (*1942*)). Commercial driers which had been used for years in the drying of prunes, raisins, apples, and hops have been adapted, where it was possible to do so, to the drying of vegetables and soup mixtures. Chace describes the different types of driers available for commercial dehydration and emphasizes factors and variables which must be taken into account in the production of dehydrated foods of good quality. Such variables include: type of vegetable to be dried, time of harvesting, method of blanching, capacity of drier for each type of food, type of drier (parallel, counter, or cross flow), final moisture content, method of packaging, insect control, and storing for shipment.

It is clear that treatment of vegetables between time of harvest and delivery to the dehydrator influences the vitamin content of the raw product. Consequently the vitamin content of the finished product depends, to a large degree, on the vitamin content of the raw product prior to blanching and drying. When leafy materials are permitted to stand overnight in lug boxes, as much as one third of the vitamin C may be lost. Under unusually bad conditions, two thirds of the vitamin C in spinach may be lost before the material reaches the drier.

Vitamin losses in water blanching are appreciable but can be reduced by using the same water repeatedly, and controlling the solids content of the blanching water. Figures are given to show the superiority of steam blanching over water blanching. For example, only 14 per cent of the ascorbic acid in cabbage was lost by steam blanching, while 51 per cent was lost by water blanching. In general, losses of ascorbic acid by water blanching were from two to three times greater than when steam blanching was used.

Food technologists attempt to obtain a product of good color and quality which will store well, rehydrate properly, and be attractive and palatable when cooked. Studies by Chace indicate that carrots should be dried down to 5 per cent moisture and stored in either carbon dioxide or nitrogen. Flavor is better in the former but carotene preservation is greater in the latter. Dehydrated

cabbage of low moisture content (3.6 per cent) contained 354 mg. per 100 g. of ascorbic acid immediately after drying. During sixteen weeks of storage in air the ascorbic acid fell to 230 mg. per 100 g. When the dehydrated cabbage was stored with a moisture content of 10.2 per cent for the same period the ascorbic acid content was 21 mg. per 100 g. Freshly dehydrated carrots of low moisture content (6.4 to 7.2 per cent) contained 140 mg. of carotene, 0.39 mg. of thiamine and 0.37 mg. of riboflavin per 100 g. After sixteen weeks of storage no significant changes had occurred in thiamine or riboflavin but carotene varied from 27.2 mg. per 100 g. (in oxygen) to 110 mg. per 100 g. (in nitrogen).

Farrell and Fellers (*Food Research* **7,** *171 (1942)*) found a thiamine content of 0.98 mg. per 100 g. in freshly dehydrated green snap beans, 16 per cent of which was lost after one year of storage. The riboflavin content of the beans, 2 mg. per 100 g., had not changed after one year. However, 96 per cent of the ascorbic acid was destroyed during the same storage period. These writers also emphasize the necessity of early and efficient blanching to ensure the maximum content of vitamins in the dehydrated product.

Hauge and Zscheile (*Science* **96,** *536 (1942)*) have studied the effect of commercial dehydration on the vitamin A value of eggs. The dried eggs were made by spraying fresh liquid eggs in a Mojonnier drier. Samples of homogenized fresh eggs were collected every half hour, during a six hour period, as they entered the drier and of dried eggs as they left the drier. Composite "on the hour" samples of each were made up for analysis. Similar composite samples were made of the "half hour" collections. After saponification and extraction with ether, spectroscopic observations were made at 3240 Å and 4370 Å, to indicate respective changes in vitamin A and total carotenoid content. Since the characteristic absorption curves of extracts from fresh and dried eggs were identical in the visible region and similar in the ultraviolet, it was concluded that losses were exceedingly small. Biologic assays on the same materials, stored at −18°C. confirmed the spectroscopic work, viz., that there was little or no loss of vitamin A during spray drying. Potencies of these samples, on the dry basis, approximated 44 I. U. per gram.

Since increasing quantities of dehydrated foods are being shipped to our armed forces and to our allies under the Lend-Lease program, more research work of this type should be done. While laboratory dehydration experiments are important and should be continued, we should know more about the nutritive value of the dehydrated foods that are being made by commercial processes.

Industry and nutrition workers should recognize the other's primary aim, the first striving to produce an attractive and appetizing product, the second to obtain one containing the maximum of original nutrients. The evidence now indicates that properly dehydrated foods are likely to compare favorably in nutritive value with the same foods processed by other methods, except for their vitamin C content.

Years of research by the manufacturers of canned foods brought about improvements in food processing to the point where the vitamin content of commercially canned foods is often approximately equal to the fresh products from which they were made, and usually superior to that of home processed foods. There is reason to believe that similar research efforts applied to dehydration processes will yield comparable results.

EGG WHITE INJURY IN THE RAT

Pruritic exfoliative dermatitis develops when young rats are fed a diet containing uncooked egg white as a source of protein. This condition clears after the administration of biotin or biotin-rich foods. The animals also develop an abnormal posture, gait, and hypertonicity, most striking at the height of cutaneous involvement. According to Sullivan, Kolb, and Nicholls (*Bull. Johns Hopkins Hosp.* **70,** *177 (1942)*) the most striking feature of this abnormal posture is the excessive elevation and rounding of the lumbosacral spine. There is extension of both the fore and hind extremities with a deliberate gait and a tendency to step off the top of the digits. No ataxia was noted.

Post mortem examination of affected animals disclosed no pathology of the forebrain, hind-brain, spinal cord, posterior root ganglion, or sciatic nerve. The skeletal muscles showed a loss in longitudinal striations, decrease in diameter of muscle fibers, and a swelling and increase in sarcolemmal cells. In some instances whole muscle fibers appeared to be destroyed.

Because similar muscle lesions have been described in vitamin E deficiency Sullivan and associates administered alpha-tocopherol to 6 rats on the uncooked egg white ration in doses of 20 mg. orally and 20 mg. subcutaneously. None of the rats showed any clinical manifestation of vitamin E deficiency. There was no evidence that alpha-tocopherol delayed or modified signs of egg white injury in any manner. The muscle lesions observed are probably not specific for any one deficiency but occur in a variety of deficiency (and other) diseases associated with malnutrition and degeneration of the muscles. Follis (*Bull. Johns Hopkins Hosp.* **71,** *235 (1942)*) found muscle lesions, similar to those described in vitamin E deficiency, in rats deficient in both thiamine and potassium, but not in animals deficient only in thiamine or potassium.

The abnormal posture, gait, and hypertonicity in rats suffering from egg white injury responded favorably to treatment with biotin or to substitution of cooked egg white or other protein in the diet for the raw egg white. The authors believe that the hypertonicity can be explained by the irritability caused by the severe pruritus rather than the pathologic findings in the muscles.

In previous experiments Sullivan and associates prepared a commercial yeast autolysate and later a yeast extract (proved subsequently by rat assay to be low in the vitamin B-complex). These were used as sources of the vitamin B-complex. In both instances there was a rapid loss in weight followed by flaccid paralysis, particularly in the hind extremities, and death. Large doses of biotin failed to prevent paralysis and death. The paralysis however was prevented by the addition of thiamine to the diet; and further substitution of a potent yeast extract for extracts low in B-vitamins resulted in rapid growth and permitted the characteristic picture of egg white injury to develop. Sullivan and associates conclude that "flaccid paralysis occurring in connection with experiments on the production of the disease is the result of a complicating thiamine deficiency."

The difficulty of drawing conclusions from animal experiments as to what lesions occur in man, with specific vitamin deficiencies, is illustrated by a comparison of these findings of Sullivan and associates for thiamine deficiency in the rat with those of Wintrobe and co-workers (*Bull. Johns Hopkins Hosp.* **71,** *141 (1942)*) for the same deficiency in pigs. Wintrobe and associates observed no neurologic signs or symptoms and no degenerative changes in the nervous system of pigs in which thiamine deficiency of long duration was produced.

NOTES

Bureau of Human Nutrition

Formation of a Bureau of Human Nutrition and Home Economics with the appointment of Professor Henry C. Sherman as its Chief has been announced by Secretary of Agriculture, Claude R. Wickard. This new bureau is a consolidation of two agencies in the Agricultural Research Administration, that of the Bureau of Home Economics and the Division of Protein and Nutrition Research of the Bureau of Agricultural Chemistry and Engineering. It represents an expansion of the nutritional and food research activities of the Department of Agriculture which is vital to the health of civilians and the armed forces, particularly under war conditions.

Dr. Sherman is one of the world's outstanding nutritionists. He did much of the groundwork in what is today called "the newer knowledge of nutrition," and the work of his colleagues and former students is also well known. He has been Mitchell Professor of Chemistry at Columbia University since 1924, and has published many books and research articles which are classics in their field. Dr. Sherman is a member of the Editorial Committee of NUTRITION REVIEWS.

Nutrition and Food Supply

The January 1943 issue, volume 225, of "The Annals" of the American Academy of Political and Social Science (3457 Walnut Street, Philadelphia) is devoted to "Nutrition and Food Supply: The War and After." This volume contains interesting discussions on nutrition in all its phases. The editor in his introduction emphasizes the incompleteness of the book with respect to food preparation, food processing, and the "food situation" in general. But the phases that are discussed are done thoroughly and in detail.

The section on "Science and Nutrition" deals with deficiency diseases and the specific vitamins, and contains a revealing study of the effect of soils and climate on food and the consequent well-being of the inhabitants. Many case studies are reported, covering a fair cross section of the geography of diets for the United States.

"Food Supplies and Public Policy" deals with food production in this country, the British Empire, Europe, Asia, and the "Other Americas"—in fact all countries whose food supplies in any way affect the prosecution of the war. The difficulties of feeding the civilian population and industrial workers are discussed by competent authorities. The aspects of postwar food production are considered in relation to each problem.

The division entitled "Consumption and Distribution" covers such timely questions as buying power, rationing, and price ceilings. Surpluses and scarcities, and the hardships they entail on producer and consumer, are discussed. Problems of fair price fixing for both high and low income groups are considered. Several articles deal with feeding of the armed forces. Lend-Lease is explained from an angle which we in this country are often inclined to lose sight of—it is not a one-way arrangement but a project of mutual assistance and benefit.

Food production, marketing, and processing is reviewed in several short articles. The last section of the volume is devoted to exhaustive reviews of books dealing with many current political, economic, and social questions.

The book as a whole is certain to be helpful to all who are interested in any of the many phases of today's food problems. Particularly should it be of value to teachers in the field of nutrition.

Meat Rationing

Meat rationing should result in more widespread use of the glandular organs,

inasmuch as these cuts of meat are usually more available. This fact has important nutritional significance.

These animal products are excellent sources of proteins of high biologic value, minerals, and of vitamins A and the B-complex. One hundred g. of beef liver (a small serving) supply approximately 25 per cent of the daily thiamine requirement for the average adult, 136 per cent of the riboflavin, and 116 per cent of the niacin. Beef heart has a higher thiamine content, supplying 45 per cent of the daily requirement as well as 40 per cent of the riboflavin, and 45 per cent of the niacin per 100 g. The same amount of kidney yields approximately 18, 93, and 66 per cent respectively, while the values for beef muscle average 15, 12, and 50 per cent.

These meats are especially good sources of iron, a high percentage of which is "available." The available iron in beef liver and heart amounts to 70 per cent of its total iron content as compared to 50 per cent for beef muscle and 20 per cent for spinach, according to the data given by Parsons (*J. Am. Dietet. Assn.* **38,** *385 (1942)*). Parboiling or soaking the glandular organs in order to remove the strong flavor results in dissolving out water soluble substances, and from the nutritional standpoint, this process should be minimized.

The soybean will also receive greater attention and wider use. It contains roughly 17 per cent of protein of high biologic value, it is a good source of the vitamin B-complex, and 80 per cent of its iron content is "available."

Food Composition

The Diet Therapy Section of the American Dietetic Association, under the chairmanship of Ruth Cowan Clouse, has performed a valuable service by compiling recent figures for mineral and vitamin values of foods (*J. Am. Dietet. Assn.* **18,** *553 (1942)*). The table includes values which have appeared in the literature during the past year and presents a fine survey and bibliography on the latest vitamin and mineral analyses. It fills a much needed gap in presenting the possible vitamin content of foods to many of which no vitamin values have hitherto been attached. These values should by no means be considered as final and anyone using them should bear in mind that the evaluation of a given foodstuff cannot be applied without reservation to other samples; the up-to-the-minute values have been obtained in many instances by new and therefore somewhat tentative methods. In many cases the data necessarily represent the unconfirmed work of one laboratory. Nevertheless each new compilation of this kind provides convenient and valuable reference material that will help serve as a guide for practical work.

Riboflavin in Foods

With studies indicating an insufficiency of riboflavin in the diet of many Americans, a recent report by Munsell (*Food Research* **7,** *85 (1942)*) on the riboflavin content of common foods purchased on the retail market in New York City is of particular interest.

The rat growth method of assay was used. The food tested and methods of sampling are described. The results are presented in a table which includes also values for the same items given by other investigators. Of the foods tested cheddar cheese showed the highest riboflavin content (546 to 600 micrograms per gram). Dried legumes were also excellent sources. Milk, beef muscle, and salmon had in excess of 200 micrograms per 100 g. The author confirmed the work of others as regards the high riboflavin content of milk, beef muscle, and salmon. Tubers and roots were low. Fresh peas and green endive approximate the values of milk and muscle meats. Leafy green vegetables such as broccoli and spinach came second to cheese, while lettuce, cabbage, and green pepper gave low values.